Chapter - 6
Water Quality Areas:
Riparian Forest Buffers and Wetlands

1. Introduction

These areas are dominated by land-water relationships. They include streamside forests, stream banks, flood plains, wetlands, and other areas that are the contact points between land and water. Their management is critical to not only preventing water pollution, but to cleaning up water through the filtering of sediments, uptake of nutrients, and stabilization of water temperature and flow conditions. In addition, these areas are some of the most biologically rich portions of the landscape, functioning as habitat for the widest variety of plants and animals, both aquatic and terrestrial. It is becoming generally recognized that riparian areas and wetlands are key to many biodiversity issues.

The *Resource Assessment* estimates that there are around 4,000 acres of existing water quality zones, riparian forests and non-operational wetlands in the Chesapeake Forests. This is a general estimate, and will need to be adjusted as field examination provides additional data. Field personnel will identify and establish RFB's, mark boundaries, and provide GPS coordinates for updating the GIS data system.

By and large, the management of these areas relies primarily on natural processes, such as natural establishment and succession. Management activities within these areas will be designed to maintain or improve the ecological functioning of the forest, wetland, and stream systems. Any timber or fiber production from these lands will be ancillary to other management needs.

2. Riparian Forest Buffers

The primary goal of riparian forest buffers is to maintain and improve the quality of water flowing into the streams and rivers and eventually to the Chesapeake Bay from the Chesapeake Forest Project lands. Riparian forests also provide critical habitat that is an essential element of the associated aquatic ecosystem and the diversity of wildlife that utilizes riparian areas. Therefore, the management goals for riparian forest buffers are:

1. To remove sediments, nutrients, and other potential pollutants from surface and groundwater flows;
2. To maintain shade cover for streams and aquatic systems to regulate temperature and dissolved oxygen;
3. To provide a source of detritus and woody debris for aquatic systems;
4. To provide riparian habitat and travel corridors for wildlife; and,
5. To maintain or establish native plant communities.

In order to achieve these goals, the following management objectives will be used as criteria to more specifically evaluate and design potential management activities:

1. Minimize disturbance to soil structure or duff layer;
2. Avoid exposed mineral soils;
3. Prevent all rills, gullies, or ruts that may channel water flow and short circuit surface flow paths;
4. Protect mixed hardwood or mixed hardwood/conifer forest community;
5. Maintain mature forest conditions adjacent to stream; and,
6. Encourage the development of a diverse uneven age forest community in terms of species, canopy levels, and diameter class.

Stand Composition

Riparian forests should be managed to encourage a mixed hardwood or mixed hardwood/conifer community with a combination of diverse herbaceous, mid-story, and overstory plants. Hardwood species should be encouraged to ensure maximum functions for denitrification, canopy diversity, woody debris, and nutrient uptake. Riparian forests should favor species that have been shown to effectively take up nutrients including: red oak, white oak, red maple, quaking aspen, ash, basswood, yellow poplar, dogwood, red cedar, and sweet and black gum.

Vegetation Management

Any vegetation management must be designed to improve the ecological functioning of the riparian forest and stream system according to management goals and objectives. If a silvicultural treatment or management prescription is conducted, it should be limited to addressing management concerns to improve or ensure the health of the riparian forest or adjacent stands. Such concerns include insects, disease, fire, windthrow, ice damage, threatened and endangered species, critical habitat, native plant communities, invasive/exotic species, hazard fuel reduction and prescribed burning. There should be no planned clearcuts conducted within a riparian forest area. Any management activities should use the least impacting equipment, following best management practices (BMPs) and comply with all state and local regulations.

Roads

Roads should avoid riparian forests to the maximum extent possible and any existing roads within riparian forests should be evaluated for closure. If road construction is necessary in a riparian forest, all related BMP's for road construction should be followed including:

1. Perpendicular alignment to riparian forest to minimize impact
2. Utilizing temporary stream crossings when possible
3. Adequate sizing of crossing to avoid affecting flow
4. Discarding slash and debris from right-of-way clearing outside of stream area.

Herbicide and Fertilizer Use

No fertilizer or aerial application of herbicides should be permitted within riparian forests. If aerial spraying or fertilizing is planned for stands adjacent to a riparian forest, the riparian forest must be clearly designated and GPS-established to protect the riparian forest from application or drift. Chemical applications within riparian forests will only be permitted for purposes of improving the ecological functioning of the riparian forest for its management goals and will be limited to spot applications and direct application to the target plant.

3. Non-operational Wetlands

Ecologically, wetlands are defined as areas that are saturated or inundated enough to influence soil characteristics and to support a wetland plant community. Under this definition, most of the Chesapeake Forest Project lands are wetlands due to the low relief and high water tables in the region. Therefore, the general forest management guidelines address some of the special management consideration required for forested wetlands. However, some wetland areas are not suitable for timber production and therefore require their own management guidelines. These non operational wetlands include all areas designated in the stand classification system as non-operable areas and described as marsh (M), bottomland (B), non-productive (NP) or swamps (S), but not included in riparian forest buffers. Additionally, areas within soil management group 5 will be included as wetland areas. *(Appendix D).* Any currently non-designated Delmarva Bays, watershed improvement projects, or other newly identified non-operable wetland areas will also be included. Non-operational wetland management guidelines will also apply to wetland buffers, which extend 100 feet from the edge of freshwater non-operational wetlands to provide upland habitat for amphibians. This buffer will need to be established in the field because some stands designated as wetlands include an adequate buffer but others do not.

The Management Goals of wetland areas will be as follows:

1. Provide high quality wetland systems including associated upland ecotones
2. Maintain or enhance any unique biological communities that may be present
3. Maintain or restore hydrologic and water quality functions of wetlands, including flood storage, groundwater recharge, denitrification, nutrient uptake, and sedimentation
4. Maintain or establish a native wetland plant community

In order to achieve these goals, the following management objectives will be used as criteria to more specifically evaluate and design potential management activities:

1. Minimize disturbance to soil structure or removal of duff layer
2. Encourage development or maintenance of a native wetland plant community
3. Prevent further ditching (to avoid altering the hydrology of the wetland)

Vegetation Management

Within non-operational wetland areas, management activities should encourage the establishment of native wetland plant communities. Within the wetland buffer, management activities should encourage a healthy forest with a diversity of species, canopy levels, and diameter classes. Any vegetation management must be designed to improve the ecological functioning of the wetland system according to management goals and objectives. There should be no planned clearcuts conducted within a wetland area unless needed to re-establish or favor native wetland species. (An example of this would be the removal of woody vegetation within a Delmarva Bay) If a silvicultural treatment or management prescription is conducted, it should be limited to addressing management concerns that threaten the health of the wetland, the wetland buffer, or adjacent stands. Such concerns include insects, disease, fire, windthrow, ice damage, threatened and endangered species, critical habitat, native plant communities, invasive/exotic species, hazard fuel reduction and prescribed burning. Any management activities should use the least impacting equipment, follow best management practices (BMP's) and comply with all state and local regulations.

Stand Composition

Within wetland areas and wetland buffers, emphasis will be placed on maintaining and encouraging a diverse community of native wetland plants. Particular emphasis will be placed on maintaining any unique biological communities present at a site. In forested wetland areas and buffers, emphasis will be on maintaining or encouraging native species to maximize denitrification and to provide leaf litter and woody debris as food and cover for aquatic wildlife.

Herbicide and Fertilizer Use

No fertilizer or aerial application of herbicides will be done within wetlands. If aerial spraying or fertilizing is planned for stands adjacent to a riparian forest, the wetland must be clearly designated and GPS-established to protect the riparian forest from application or drift. Chemical applications within wetlands will only be permitted for purposes of improving the ecological functioning of the wetland to meet management goals and will be limited to spot applications and direct application to the target plant of products approved for aquatic application to the target plant.

Roads

Roads should avoid wetland areas and wetland buffers to the maximum extent possible, and any existing roads within wetland areas should be evaluated for closure. If road construction is necessary in a wetland area, all related BMP's for road construction should be followed including:

1. Align to minimize impact;
2. Discard slash and debris from right-of-way clearing outside of wetland areas; and,
3. Avoid impacts to wetland hydrology.

4. Riparian Forest Buffer Structure

Riparian forest buffer establishment and layout on the Chesapeake Forest Project will follow the zonal concept developed by the US Forest Service, and extend that concept further to accommodate wildlife habitat needs in riparian zones. The structure chosen begins with two zones (1 and 2) designed primarily for the protection of water quality (Table 16). It then extends with two more zones (3 and 4), with the choice between the two depending on the wildlife habitat needs of the area in question. Zone 3 includes areas where no special wildlife habitat needs are foreseen, and is intended to provide additional buffering for water quality protection, and additional interior forest habitat to help support most common wildlife species. Zone 4 is an expanded riparian forest zone designed to improve habitat for forest interior dwelling birds (FIDS) and Delmarva fox squirrels (DFS), both of which have been shown to benefit from a wider riparian zone of relatively undisturbed mature forest (See chapter 7).

The zones are identified as follows in the plan. Actual layout must be done on the land, in response to the soil, topographic, and vegetative conditions encountered in each place. The zones are defined in terms of minimum width from the edge of the water, so are only relevant to one side of the stream or wetland. Obviously, where a stream or wetland occurs on the interior of a Chesapeake Forest parcel, the total riparian forest created would be twice as wide as indicated. Many times, however, the streams form the property boundaries of the Chesapeake Forest lands, so the best that can be done is to establish and manage the best one-sided riparian forest possible, and attempt to encourage the adjacent landowners to take similar measures.

The Water Quality/Wildlife Buffer zones that are utilized are:

Zone 1- the area immediately adjacent to the stream. Widths will be established according to the guidelines in Table 17 but average 25' from the edge of the water. Zone 1 will be managed to enhance and maintain the ecological function of the aquatic system. Emphasis will be placed on stabilizing stream banks, and encouraging the establishment and maintenance of a mature forest stand, thus providing litter fall, woody debris, and shading the stream. Trees along the stream bank that are ready to fall, and in doing so would create bank instability, may be cut down and not removed as part of an approved watershed improvement project.

Zone 2- an additional extension from the edge of Zone 1. The width of Zone 2 will be established according to the guidelines in Table 17 but average 100' from the edge of the water. Zone 2 will be managed to enhance the function of the forest in the removal of nutrients from overland flow and shallow underground aquifers. Management activities will encourage the creation and maintenance of mature mixed forests. Tree removals, through thinning or harvest, will be done only to improve riparian forest function.

Zone 3-these zones serve as expanded Wildlife Buffers. In areas not designated as DFS or FIDS core areas, this zone will extend a minimum of 150 feet from the edge of the water (usually 50-75 feet from the edge of Zone 2). These zones will provide additional nutrient uptake, as well as produce increased interior forest habitat for wildlife. They will be managed for the creation and maintenance of mature mixed forests. Harvesting will be done by singletree selection, designed to enhance wildlife habitat and buffer function. Any harvest will leave a minimum basal area of 70 square feet. Because a mixture of hardwoods and pines is the goal, no aerial herbicides or fertilizers will be used on these zones.

Zone 4 - These are expanded wildlife habitat zones used in areas marked as core habitat for Delmarva Fox squirrel and Forest interior dwelling birds. They will extend a minimum of 300 feet from the edge of the water (usually 200-225 feet outside Zone 2) and provide, in areas where both sides of a stream are included, a riparian forest buffer of 600 or more feet in width. Since they will ordinarily be adjacent to plantations on the upland side, these areas will need to be clearly marked and identified with GPS coordinates so that aerial operations on adjoining lands do not affect them. The management will be similar to Zone 3, in that there will be no planned clearcuts, and all timber harvest will be done by selection or thinning methods, designed to retain at least 70 square feet of basal area and encourage the type of species balance that will be best for wildlife habitat.

Table 16. Functions of Water Quality Wildlife Buffer Zones

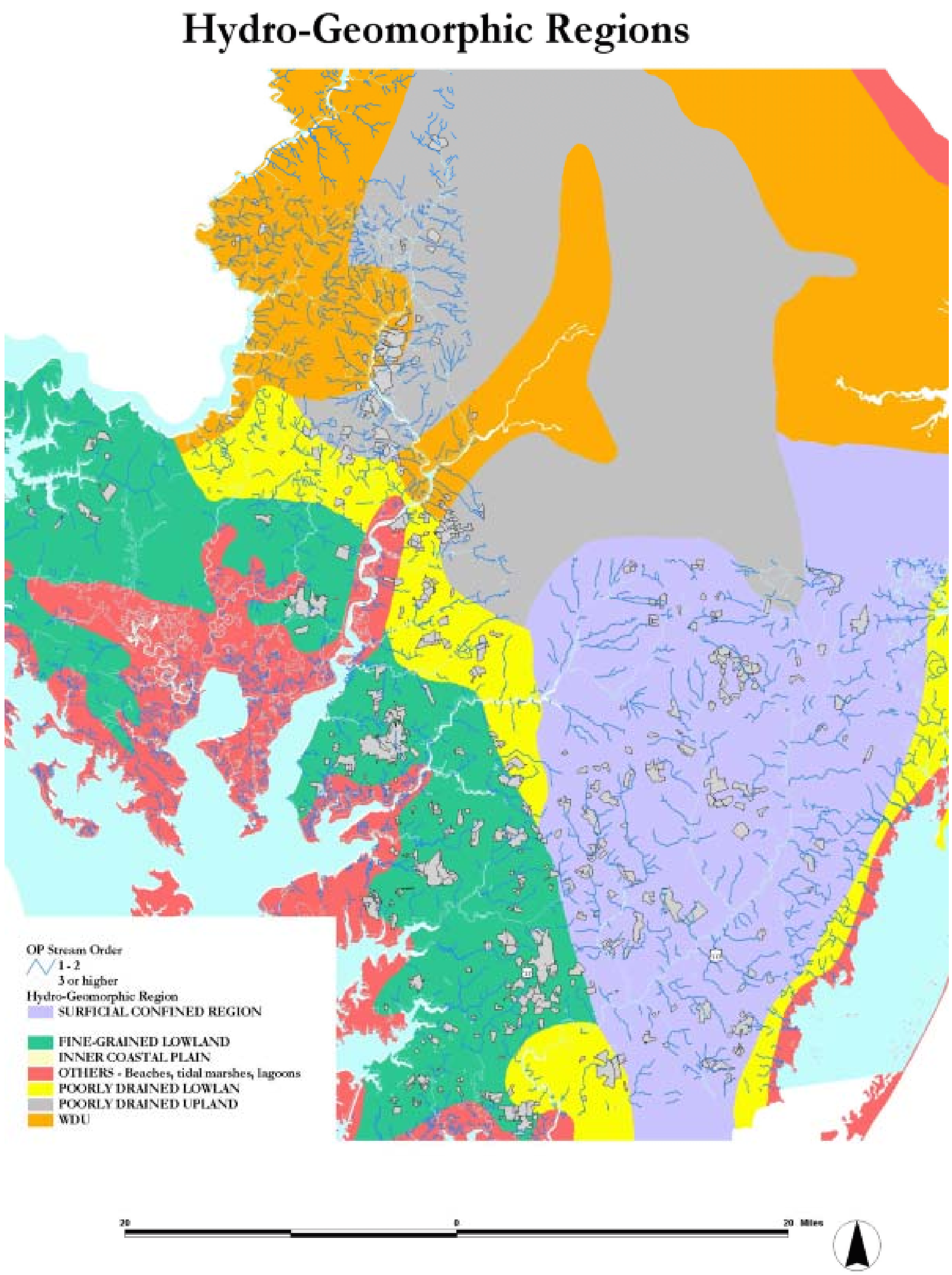
Zone	Function
Zone 1	Protection and enhancement of aquatic ecosystem, stream bank protection
Zone 2	Removal of non point pollution, nutrient uptake from surface water and shallow groundwater
Zone 3	Additional wildlife habitat, and added nutrient uptake for water quality improvement
Zone 4	Buffer for areas located within DFS core habitat, provides additional interior forest habitat for DFS and FIDS

5. Riparian Forest Buffer Width for Zones 1 and 2

The approach taken for the planning of riparian buffer criteria for water quality and hydrologic objectives is based on the consideration of the geomorphic setting, meaning that the buffer widths required to manage for desired hydrologic and/or water quality conditions are based on the landscape conditions (See Table 17). The desired hydrologic conditions have been identified as those that mimic, to the extent possible, the natural hydrologic conditions characteristics of the specified geomorphic setting, landscape feature, and/or drainage network location. The desired water quality conditions target the removal of 90% of the input concentrations of total suspended sediment, total nitrogen, and total phosphorous (100 * output-input / input). The specified buffer widths have been based on groundwater removal rates of nitrate nitrogen and surface removal rates of sediment, nitrogen, and phosphorous documented in Maryland’s Coastal Plain.

Two scales are considered in the physically based buffer planning approach, including the *hydro-geomorphic regions* (Figure 13) on the Lower Delmarva Peninsula and *drainage network*

Figure 13. Hydro-geomorphic regions on the lower Delmarva Peninsula and locations of Chesapeake Forest Lands



locations. These scales were used to differentiate generalized flow paths (surficial or subsurface) and dominant pollutant pathways. Special geomorphic features within the lower Delmarva Peninsula were also considered, including Carolina (Delmarva) Bays, relic dune formations, and well drained land areas within poorly drained settings. Drainage network locations were differentiated based on stream order.

Two primary assumptions are associated with this approach: 1) there is a consistency in the physical environment characterizing each hydro-geomorphic region, with the exception of the special features that have been identified; 2) there are different geomorphic processes occurring within the drainage network, including the convergence of localized groundwater and surface water flows in headwater areas, sediment production in headwater non-tidal channels, and sediment storage in higher order non-tidal channels. Based on these assumptions, it is concluded that opportunities are greatest for watershed scale pollutant removal in headwater areas and geomorphic floodplain environments associated with higher order stream channels. It is also concluded that the existing artificial drainage ditches are currently the most efficient pollutant pathways in the poorly drained areas, thereby providing a focus for the reduction in pollutant export efficiency. The recommended buffer widths therefore reflect consideration of the hydrologic signature of the landscape setting, which is assumed to promote possible secondary benefits related to the conservation of natural hydrologic conditions in aquatic habitat areas.

Table 17. Riparian Forest Width Guidelines

Geomorphic Feature	Geomorphic Region	Width (Zone 1/Zone 2)	Soil Type	Hydrology / Dominant Pollutant Path	Rationale / Strategies
1,2 order stream (Case 1)	▪ Well Drained Upland ▪ Surficial Confined ridges, dunes* Poorly Drained Upland (PDU) hilly topo	100-foot(25 foot/75 foot)	Non-hydric Soils adjacent to riparian area, including: ▪ Well Drained outside of riparian areas ▪ Well drained sandy loam in Surficial Confined ridges/dunes ▪ Well drained sandy loam in Poorly Drained Upland hilly areas	▪ Water table > 2' outside of riverine areas ▪ Subsurface	*Rationale:* ▪ Well drained soils are commonly associated with relatively rapid groundwater movement and faster. surface flows, which reduces runoff pollutant removal efficiency. ▪ Well drained soils are commonly associated with higher topographic relief and greater sensitivity to erosion. *Strategies:* ▪ Extend residence time for surface and subsurface flows ▪ Optimize opportunity for buffer/groundwater interaction in low topographic areas near initiation of subsurface flow paths. ▪ Increase surface flow path distance and resistance in erodible, steeply sloped soils. ▪ Minimize opportunities for in-channel sediment production from high rates of runoff .
3rd order or greater streams	▪ Well Drained Upland, Poorly Drained Upland, Surficial Confined	Geomorphic Floodplain (All Zone 1)	▪ Hydric ▪ Well drained on side slopes	▪ Water table < 2 ▪ Combined	*Rationale:* ▪ Floodplain areas are commonly incised into the landscape, thereby interacting with deeper groundwater movement ▪ Floodplain areas are commonly characterized by wetland conditions. ▪ Floodplain areas associated with higher order channels are commonly sediment deposition areas *Strategies* ▪ Optimize potential for buffer / groundwater interaction in areas with low topographic position in the landscape.

Table 17. Riparian Forest Width Guidelines

Geomorphic Feature	Geomorphic Region	Width (Zone 1/Zone 2)	Soil Type	Hydrology / Dominant Pollutant Path	Rationale / Strategies
					▪ Provide opportunity for surface interception of pollutants. ▪ Optimize opportunity for fluvial sediment trapping.
Tidal waterways	▪ Coastal Lowlands	50-foot (All Zone 1)	* Hydric	▪ Tidal ▪ Water table < 2'	*Rationale:* ▪ Pollutants moving through the terrestrial borders often move directly into the tidal areas. ▪ Tidal areas are often bordered by a tidal marsh system. ▪ Poorly drained soils can be associated with high water table or soils of low permeability, which are conducive to wetland conditions and low rates of runoff infiltration. ▪ Poorly drained soils are found in relatively flat areas with slow moving subsurface and surface flows, which increases the runoff pollutant removal efficiency through uptake and denitrification. *Strategies:* ▪ Provide opportunity for surface interception of pollutants. ▪ Optimize effectiveness of tidal marsh system, where present.
Unplugged ditch system	▪ All hydro-geomorphic regions	75-foot(25-foot/50-foot)	Hydric	▪ Water table < 2' ▪ Surface	*Rationale*: ▪ Artificial ditches are the most efficient pollutant pathways in poorly drained areas. ▪ Artificial ditches modify natural hydrologic conditions by drained the adjacent land areas and increasing base flows to receiving natural waterways. ▪ Poorly drained soils can be associated with high water table or soils of low permeability, which are conducive to wetland conditions

Table 17. Riparian Forest Width Guidelines

Geomorphic Feature	Geomorphic Region	Width (Zone 1/Zone 2)	Soil Type	Hydrology / Dominant Pollutant Path	Rationale / Strategies
					and low rates of runoff infiltration. ▪ Poorly drained soils are found in relatively flat areas with slow moving subsurface and surface flows, which increases the runoff pollutant removal efficiency through uptake and denitrification. *Strategies:* ▪ Provide opportunity for surface interception of pollutants. ▪ Optimize potential for denitrification in shallow organic surface layers.
Plugged ditch system+	▪ All hydro-geomorphic regions	0-foot	Hydric	▪ Water table < 2' ▪ Surface	*Rationale*: ▪ Artificial ditches are the most efficient pollutant pathways in poorly drained areas. ▪ Artificial ditches modify natural hydrologic conditions by drained the adjacent land areas and increasing base flows to receiving natural waterways. *Strategies:* ▪ Reduce efficiency of downstream pollutant export. ▪ Provide enhanced opportunity for denitrification. ▪ Restore hydrologic condition natural occurring with the geomorphic setting. ▪ Restore natural baseflow conditions in downstream natural channels.

+ More detailed criteria can be developed for specific soil types (Ex. 1: Evesboro sandy loam correlate well with Surficial Confined ridges/dunes; Ex. 2: Galestown sandy loam correlate with Poorly drained upland hilly areas)

++ Provides opportunity for forest harvesting operations in extensive areas upstream of ditch plugs due to elimination of ditch channel buffers